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But MARY, the rarest, the fairest, sweet flower,
That ever adorn'd the green banks of the Main:
Compared with whose beauty, the eglantine bower,
The rose and the lily, how trifling and vain!

How lovely her bosom, where friendship and feeling
Still heave for misfortune, the dear, tender sigh!
How sweet are her looks, ev'ry beauty revealing,
And mild is the lustre that beams in her eye!
The blush of her cheek still outrivals Aurora,
When beauty and music awake the young dawn,
And sweeter her smile than the smile of sweet Flora,
When cowslips and daisies bedeck the gay lawn.

And O! lovely maid! may thy beauties still flourish,
Unnipp'd by the blast of misfortune's rough gale!
May virtue attend thee, thy goodness to nourish,
And no ruffian hand the sweet blossom assail!
May fortune's best smiles, lovely maid, never leave thee,
Through life's fleeting scenes, as thou journey'st along,
And curst be the villain would seek to deceive thee,
Or offer thy virtue and innocence wrong!

Let lordlings exult in their titles and treasure,
Where courts and where grandeur extend their proud blaze;
And proud city beauties may listen with pleasure,
While poets unblushing re-echo their praise;
No more shall they boast of the city or palace,
Bedeck'd with rich beauties, a gay gilded train,
For now there's a fairer adorns our green vallies,
'Tis Mary, sweet Mary, the flower of the Main!

DISCOVERIES AND IMPROVEMENTS IN ARTS, MANUFACTURES, AND AGRICULTURE.

Extracts from an Essay, No. 16, on the management of light in Illumination; by Benjamin Count of Rumford, F.R.S.

THE art of illumination, although it is undoubtedly one of the most useful that have been invented by man, and contributes perhaps more than any other to his comfort and convenience, in all countries and in every class of society; it has, nevertheless, been little cultivated: it has not even been considered as an art; for the technical terms have not yet been invented, which are indispensably necessary in order to render it possible to treat of it in a clear and satisfactory manner.

My attention was first turned to this interesting subject in the year 1789, when, being actively engaged in the public service of the late Elector Palatine, reigning Duke of Bavaria, I was employed by his Most Serene Highness in establishing houses of industry for the poor, in the cities of Mannheim and Munich. In lighting up these spacious establishments, I first learnt to know how much room there was for improvement in the art of illumination: and since that time, the subject has frequently been the object of my meditations, and of a variety of experimental researches.

It was with a view to the prosecution of these investigations, that I contrived the photometer for measuring the relative intensities of the light emitted by luminous bodies, which is described in the first volume of my Philosophical Papers, page 270. With the assistance of that instrument, I determined the relative quantities of light that are emitted in the combustion of the various inflammable substances most commonly used in procuring light, viz. of bees-wax, tallow, and several of the fat oils. An account of the results of these experiments was read before the Royal Society the 6th February, 1794, and was afterwards published in the Philosophical Transactions; and also in the first volume of my Philosophical Papers.

Having found, from the results of these and of other experiments, that the purest light, and most beautiful illumination, may be obtained by means of lamps properly constructed, for less than *one-eighth* part of the price that the same quantity of light would cost, if it were furnished by wax-candles; and, consequently, for about *half* the sum it would cost when furnished by tallow-candles, I saw that very great advantages could not fail to result to the public, from such improvements in lamps as should render them neat and elegant, and prevent their being any longer liable to those disgusting accidents to which they have hitherto been exposed.

Animated by a strong conviction of the importance of the subject to society, I took great pains to make myself thoroughly acquainted with lamps, and with the causes of their imperfections, and I made a great many experiments with a view to improve them. These researches employed my attention occasionally during several years, and in the prosecution of them I actually caused to be constructed more than *one hundred* lamps, (all differing from each other, more or less,) as I found, to my no small surprize, on counting them, as they were taken away from a store-room, to be carried into another house, on changing my lodgings.

As it is a duty incumbent on those who publicly recommend new improvements, not only to show their utility in the clearest manner, but also to explain the principles on which they are grounded; in treating of illumination, I must first investigate the principles on which that art must be established, and must then point out the particular objects which must be had in view in all attempts to improve the instruments employed in the practice of it.

As artificial light is employed to illuminate surrounding objects, to the end that they may be easily and distinctly seen, it is necessary to inquire, what circumstances are favourable to distinct vision, and also what circumstances are unfavourable to it.

If the facility with which objects are distinguished by the eye, depended solely on the intensity of the light by which they are illuminated, this particular inquiry would be superfluous; but this is very far indeed from being the case.

We can see objects, and even very distinctly, when they are illuminated by light of very different degrees of intensity.

It is a well known fact, that a book may be read at night by the light of the full moon, when the air is very clear; and every body knows, that it may be read when illuminated by the direct rays of a bright meridian sun: the difference of the intensities of the light in these two cases is truly astonishing: the intensity of the light of the sun is to that of the full moon, at the surface of the earth, as *three hundred thousand* to *one*.

But notwithstanding this astonishing power of accommodation, possessed by the organ of sight, yet, when the eye passes suddenly from a strong light to one much more feeble, and *vice versa*, nothing can be distinctly seen for some moments. It is true, that the eye soon recovers from these momentary derangements, and that habit has rendered them so familiar to us, that we seldom take any notice of them; but it is nevertheless most certain, that they not only injure the eye very much, and weaken it in such a manner as to impair its faculties at a very early period of life, but that they also render it impossible to see surrounding objects so distinctly as they might be perceived, even with much less light, were the illumination established on better principles.

The facility with which we see objects distinctly, depends much on their shadows. When the lights and shades are simple and distinct, they are necessarily well defined, and we see distinctly; but when the light arrives in several directions at the same time, the luminous points of the object and its shadows are so blended and confused, that distinct vision is impossible, whatever may be the intensity of the light present.

A portrait-painter never permits light to come into his room, but through one single window; and those who are desirous of having their apartments illuminated at night in the pleasantest manner possible, must contrive to have all the light come from one source.

If every sudden change in the intensity of the light that strikes the eyes, is injurious to them, the direct rays which proceed from the flames of lamps and candles must necessarily fatigue them very much, and render it impossible to see distinctly any objects that may happen to be near those dazzling sources of brightness. A near view of the naked flame of an Argand lamp is quite insupportable, as is well known; but the advantages which would result from masking those flames, and all others used in domestic illumination, have never been justly estimated: that subject has never been properly investigated.

The only way in which the flames of lamps and candles can be masked, without occasioning a great loss of light, is to cover them by screens, composed of such substances as disperse the light, without destroying it. Ground glass, thin white silk stuffs, such as gauze and crape, fine white paper, horn, and various other substances, may be used for that purpose, and have been used very often.

This system of illumination has been universally practised by the Chinese for many ages, and so wise and so economical a nation, could not have continued to practice it so long, had it not been found to be really advantageous: but without depending on this authority, the utility of the system can be demonstrated by direct and decisive experiments.

Although ground glass appears to us to be opaque, it cannot be so in fact. In the operation of grinding it, its surface, which was smooth and even, is so ploughed and broken up, as to present an assemblage of asperities, which are invisible to the naked eye, on account of their extreme smallness, but which have all their sides smooth and shining, as may be seen by examining them with a microscope.

Now it is quite evident, that a ray of light which arrives at the smooth surface of one of those little asperities, must enter the glass with the same facility (at the same angle of incidence) as it would penetrate the surface of the largest sheet of polished glass; and it is likewise evident, that the ray having passed through the surface, must continue its course in the glass, and pass out of it on the other side, in the same manner in the one case as in the other.

If a collection of parallel rays of light, forming a small cylindrical bundle, fall perpendicularly on the polished surface of a large sheet of glass, they will pass through the glass in strait lines, and will continue their courses without suffering any change in their direction; but if these rays fall on a sheet of ground glass, they will be dispersed; and having passed through it, they will diverge in all directions.

The final direction of each individual ray will depend on the refractions it will have experienced in passing into the glass, and in passing out of it; and these refractions will depend on the positions of the planes of those infinitely small portions of the broken surface of the glass where the rays happen to pass.

If the flame of a burning candle be placed in the centre of a large globe of very fine transparent glass, its rays will pass through the glass without suffering any sensible alteration, either in their direction, or in their intensity; and the form and dimensions of the flame will be seen so distinctly through the glass, that, at a little distance, the globe might easily escape observation. But if instead of placing the candle in a globe of transparent glass, it be placed in the centre of a globe of ground glass, the rays of light will be so dispersed in passing through it, that from each visible point of its external surface, rays will be sent off in all directions, which will render the surface of the globe luminous. The flame of the candle will no longer be seen through it, but surrounding bodies will not be less illuminated on that account.

The globe will be the only luminous body which will be visible; and as the intensity of the light at its surface may be diminished, without any loss, merely by increasing that surface, by augmenting the diameter of the globe, it is evident, that by a judicious arrangement of screens of ground glass, or of other fit substances, the too vivid light of lamps may be so dispersed and softened, without any considerable loss, as to protect the eyes from injury, and at the same time render the illumination infinitely more mild, tranquil, and agreeable.

One of my first attempts to put these principles in practice, was made in the year 1800, in lighting the reading rooms and lecture room of the Royal Institution. Argand lamps, with several burners, suspended from the ceiling, or elevated on stands, were so covered by large screens of white gauze, in the form of a flat dome, or truncated cone, as to conceal the lamps entirely from the view, and at the same time, by dispersing the light over the whole surface of the dome, to moderate the too intense brilliancy of the flames.

This experiment succeeded even beyond

my expectation; and the lighting of these rooms met with such universal approbation, that I was encouraged to proceed in my endeavours to improve the art of illumination.

My next attempt was to light a large dining-room in my house at Paris, by a single luminous dome, suspended over the middle of the dining-table; and in order to prevent cross-lights, I ventured to place a cluster of burners, on Argand's principles, in the axis of this dome, and so near together, as to touch each other, and to feed them with oil from a circular reservoir, in the form of a hollow flat ring, on which the dome was supported.

As one of the objects principally had in view in contriving this illuminator, was to light a room sufficiently with one single luminous body (in order to avoid the bad effects of cross-lights), it was necessary to construct illuminators of different sizes, and also of different forms.

There are three varieties of them in use, which have all been found to answer very well the different purposes for which they were particularly designed.

1. The Balloon Illuminator, which is a luminous globe of 18, 20, or 22 inches in diameter, suspended from the ceiling, at the height of seven or eight feet; designed for lighting saloons, drawing-rooms, ball-rooms, &c.

2. The Dining-Room Illuminator, which serves likewise for lighting a billiard-room in great perfection. This is likewise suspended from the ceiling; but its screen, instead of being globular, is in the form of a dome, with a hoop about four or five inches in width suspended from the bottom of it.

3. The Table Illuminator, which is covered by a hemispherical screen or dome, is placed on a stand or foot, about 20 inches high; and is used for lighting a dining table; or reading, or working table; and it lights the room at the same time quite sufficiently, if the room be not large.

All these illuminators have circular horizontal reservoirs for the oil, which have all the same depth, viz. one-eighth of an inch, but which are of different widths and diameters, according to the number of burners which they are destined to supply.

These burners, whatever may be their number, are all placed close together, in a cluster, in the centre of the reservoir, and so near as to touch each other. They have hitherto been constructed on Argand's principles, and each of them is furnished with its separate chimney; but, from a discovery I have lately made, I think it very probable that an important improvement will soon be made, by employing one burner, with several wicks, instead of several separate burners.

I shall first give an account of the means that have been used for suspending the pendulous illuminators; and as there is nothing either new or complicated in this machinery, it may be described in a few words.

A strong hoop of brass, of about one inch in width, is suspended from the ceiling of the room in a position perfectly horizontal, by means of six chains attached to six arrows of brass, of about 0.4 of an inch in diameter, and 6.9 inches in length, which project horizontally from the outside of the hoop, to which they are firmly fixed. These chains, which are each about thirty inches in length, are all fixed above to the bottom of an ornamented baldaquin, which is a hoop of brass in the form of a crown, of about 9 inches in diameter; which hoop is suspended in a horizontal position, by means of a double cord, which passes over two pullies, fixed in a small block, which is attached by means of a hook to a staple fixed in the ceiling. This cord descends, and is attached to a counterpoise of lead in the form of a large tassel, ornamented by gilding. This tassel being made hollow, the cord by which the illuminator is suspended passing through it, is kept in its place.

The length of the cord is such, that when the illuminator is at a proper height, the heavy tassel, which serves as a counterpoise to it, has descended so low as nearly to touch the top of the crown or ornamented ring where the six chains unite; and the weight of the counterpoise is such that the friction of the cord and pullies is sufficient to prevent the illuminator from either ascending or descending, except when force is employed to raise it, or to lower it.

The crown (baldaquin), to which the chains are attached above, is of an elegant form, and it is commonly ornamented more or less with cut-glass. The chains are likewise very richly ornamented, by fixing in each of their oblong links, of gilt brass, an oblong diamond of cut-glass of about two inches in length, and one inch in width, in the middle, cut into facettes. These are called olives in France; and they cost at Paris six sous a-piece. To hide the cords, they are loosely wrapped round with thin silk stuff, of the same kind and colour with that used for the curtains of the windows. This is placed loose about them, and in such a manner as not to prevent the free action of the pullies.

Having by means of luminous screens, properly disposed, contrived to conceal all that was disgusting in the appearance of lamps; to obliterate all their shadows, which rendered them so gloomy and melancholy, to disperse the too powerful brightness of their flames, without destroying their light, and to unite a sufficient quantity of mild light in one place, to illuminate large rooms from one source; a difficulty still remained, which, if means had not been found to surmount it, must for ever have prevented these improvements from coming into general use. The spilling of the oil in transporting lamps from one place to another is an accident which is so very disagreeable, and yet so common, that no person of taste or feeling can, without considerable repugnance, permit a lamp to be brought into an elegant apartment; and it is easy to perceive, that when oil is put into large circular reservoirs, the danger of its being thrown out of them, on the least motion, is so great, that the accident could not fail to happen very often, if the most effectual means were not used to prevent it.

I was so fortunate as to hit upon a very simple contrivance for preventing the oil from being spilt in the management of my illuminators; and the means employed are so effectual, that the accident is evidently all but impossible. The person who has sold more than 200 of them in Paris, assures me that this accident has never once happened, to his knowledge, during the six years he has been engaged in the fabrication and sale of them; and he is so persuaded that it cannot happen, that he does not hesitate to place pendulous illuminators directly over the middle of the most elegant billiard-tables, even where he has no reason to suppose that the servants into whose hands they are come are particularly careful.

This contrivance, which is extremely simple, can easily be described: The reservoir for the oil, which, as has already been observed, is a flat, hollow ring, has three openings above, at equal distances from each other; they are short, vertical brass tubes, of about half an inch in height, and three quarters of an inch in diameter internally, which are soldered to the upper part of the reservoir; each of them is furnished with a brass stopper, which closes it hermetically, and each of the stoppers is perforated in its axis, and receives a screw of about a quarter of an inch in diameter, and three quarters of an inch in length, which by means of a collar of leather, closes this aperture completely, when the screw is screwed down fast in its place: but these screws are not entire; about one-third part of the substance of each of them is filed away, from the shoulder which supports the collar of leather, quite down to the lower end of the screw. This neither prevents the screw from moving regularly in the female screw, nor from closing hermetically the opening in the brass stopper when it is screwed down fast in its place; but when the screw is turned backwards one or two turns a passage is opened, by which air can pass freely in or out of the reservoir.

When the illuminator is lighted, a passage for the air to enter the reservoir must be opened, by unscrewing one of these screws, otherwise the oil cannot flow to the burners; but at all other times, all these screws must be kept screwed fast down, which will most effectually prevent the oil from being spilled, in transporting the illuminator from place to place: it would even be very difficult to make it run out at the openings of the burners, for the pressure of the external air would prevent it.

As the reservoirs of the table illuminators are small, two openings above, opposite to each other, have been found to be sufficient; but when the reservoir is much larger, three openings are useful, as they afford the means of seeing when the reservoir is placed horizontally, as also when it is completely filled with oil. There never can be any use in opening more than one of the passages for the admittance of air into the reservoir when the illuminator is lighted, and that is to be opened which happens to be nearest at hand.

As these pendulous illuminators will burn well eight or nine hours without being replenished, it will seldom be necessary to refresh them with oil while they are in actual use: if, however, that should be necessary, it may easily be done, even without extinguishing them, and without danger. But, in general, the reservoir is always to be taken away and carried out of the room, when it is to be filled, and the burners cleaned and trimmed.

As table illuminators are liable to be removed frequently from place to place, when they are not lighted, the screw which closes the passage for the admittance of air into their reservoir, should not be opened till the moment when they are lighted; but as the reservoir of this illuminator is not large, and as the tube is narrow which conveys the oil from it to the burner, there is very little danger of the oil being spilled in removing it from place to place, either when it is lighted, or when it is not lighted, even though the passage for the air should be left open.

As soon as all the wicks are well on fire, they are to be shortened, by drawing them back into their cylindrical burners, by means of their racks, or endless screws, till their flames are reduced so as to become very short, and almost on the point of being extinguished. This is *absolutely necessary* in order to prevent the upper half of the balloon, or the dome, from being scorched, and perhaps set on fire, by the heat, in being passed over the ends of the chimnies of the burners, over which it must pass, in order to its being put down into its place.

It still remains for me to give a more particular account of the table illuminator; and as it appears to me to be probable that this invention will soon come into general use, I shall be very particular in describing it.

A circular groove is made on the top of the reservoir for receiving the dome, and keeping it in its proper place; and the inside of the reservoir is made sloping. It was made of this form in order that it might less obstruct the light, and that its internal surface might serve as a reflector.

The oil is conveyed to the burner by one of the two branches, by which the reservoir is fixed to the burner.

The openings by which the air enters the burner are distinctly seen just above the level of the projecting rim of the column; and just above these openings the projecting edge of the vertical wheel is seen, which is turned round in lowering or raising the wick.

Just above this wheel is a moulding; but the illuminator would have a more simple and more elegant appearance if, by lowering the moulding to the level of the wheel, this might appear to make a part of the moulding.

The foot on which the column is placed is 5.4 inches square, and 1.5 inch thick. It is usually painted and japanned so as to resemble a piece of marble or granite.

On this square foot the plinth of the column is fixed, which is 3.35 inches square, and 0.4 of an inch thick; and on the plinth the column is placed, which is ornamented with mouldings, and often gilt and japanned. It is 1.88 inch in diameter above, and 2.1 inch in diameter below, and at its upper extremity it has a rim which projects outwards 0.4 of an inch. This rim is very useful in transporting the illuminator from place to place, as it affords a firm support for the hand.

The column is made of strong tin, and it is closed below, that it may the more conveniently serve as a reservoir for the oil which may occasionally leak out of the burner.

The burner, properly so called, is a cylinder of tin, 3.8 inches in length, and 1.05 inch in diameter, constructed on Argand's principles. It is fixed in a vertical position in the axis of a larger cylinder, which is 1.88 inch in diameter, and 5.8 in length, in the opening of which, above, the glass chimney is fixed. The lower part of this cylinder enters 1.5 inch within the column, and is firmly attached to it by means of a projecting metallic knob, situated on the inside of the column near its upper extremity. A vertical slit or opening, on one side of the cylinder, about a quarter of an inch wide, and an inch and a quarter long, permits the cylinder to enter the column, notwithstanding its projecting knob; and when the cylinder has been forced down into the column so low that this knob comes to strike against the upper part of this vertical opening, on turning round the cylinder, the column being held fast, the knob is forced into an horizontal opening, by which means the cylinder and the column are locked together, in a manner similar to that employed for fixing a bayonet to its musket. This horizontal opening in the side of the cylinder, into which the knob passes in fastening the cylinder to the column, may be about one inch in length; and instead of making it every where of the same width, it will be best to make it a little narrower towards its extremity, in order that the knob may fill it completely in that part, and on being forced into it, like a wedge, may hold the faster.

As it will seldom be found necessary to separate the reservoir from its stand, (once a month perhaps, just to pour out any small quantity of oil that may have leaked out of the burner and fallen down into the column,) it will be very desirable that the reservoir should be fixed to the column in the most solid manner, in order to prevent their being separated by any accident, while the illuminator is in use.

The square foot on which the column is placed may be made of tin, and it may be filled with sand, in order to give it sufficient weight. To prevent its scratching the table on which it is placed, a very simple contrivance has been used: Two pieces of hammered sole leather, each one inch square, being cut diagonally, they form four triangular pieces, each of which, being rivetted by three rivets to a triangular piece of strong tin, of the same form and size, care being taken to sink the heads of the rivets below the surface of the leather; on soldering these triangular pieces to the bottom of the square foot of the column, one at each of its four corners, these pieces of leather prevent the bottom of the stand from touching the table. Horn or wood might be made use of instead of leather for this purpose.

In all cases where rooms are lighted by illuminators, all other lights must be excluded; for the admission of either lamps or candles burning with naked flames, would greatly disturb that pleasing tranquillity which reigns where the light is mild and uniformly distributed; and instead of being advantageous to distinct vision, would, by dazzling the eyes, and introducing a confusion of lights and shades, render it much more difficult to see objects distinctly.

As the light of an Argand lamp is so exceedingly vivid, that when it is near at hand it may often be found to be too powerful to be agreeable, even when placed behind the screens; in that case I would recommend a very simple contrivance, which I often use, and which effectually defends the eyes without darkening the room, or sensibly diminishing the beauty of the illumination. A hoop, made of strong white writing paper, of about two inches and a half in width, is so fitted to the outside of the dome of the table illuminator below, as to embrace it exactly, and in such a manner as to be supported by it.

The use of this additional paper screen is so far from impairing the illumination of objects placed on the table, that it improves it; and it never fails to render vision much more distinct, by preventing the eyes from being fatigued and injured: and although objects in distant parts of the room will, in some places, be somewhat less illuminated, yet even there they will be seen distinctly, for the eye will be better prepared to perceive them.

I cannot finish my account of this table illuminator without recommending it in a very particular manner to the studious, and to all those who are in the habit of reading and writing by candle-light, as it gives a great deal of mild light, about six times as much as a good wax candle, it illuminates sufficiently without being near; and as its stand is considerably higher than a common candle-stick, it may be so placed as not to be seen by those who are reading, writing, or working by its light; which circumstance renders the illumination uncommonly mild and agreeable, and tends much to the preservation of the eyes.

Globes of ground glass have been in use for some time in France, and elsewhere, no doubt, for masking the flame of Argand's lamp, but their light has been found to be too powerful to be agreeable. This is not owing to any particular quality in ground glass, which renders its light dazzling and fatiguing to the eyes, but is merely owing to the too great intensity of the light at the surface of the visible object, which is owing to the smallness of that surface, or to the smallness of the balloon.

As the surfaces of globes are as the squares of their diameters, the surface of a globe of eight inches in diameter is to that of a globe of four inches in diameter, is to that of a globe of four inches in diameter, as 64 to 16, or as 4 to 1.

Hence we see, that the intensity of the light at the surface of a globular screen of ground glass, of four inches in diameter, is four times greater than it would be if the diameter of the globe were eight inches. Now, as the quantity of light emitted will be the same in both cases, surrounding bodies will be illuminated as much in one case as in the other; but the illumination will be most mild, equal, and agreeable, when the larger globe is used; and the eyes will be in much less danger of being fatigued and injured.

As the system of illumination, which I have recommended, is founded entirely on the supposition, that light may be dispersed without being destroyed, I feel it to be necessary to establish that fundamental principle in such a manner as to exclude all doubt. I shall, therefore, go over the ground again, and shall endeavour to elucidate the subject in the clearest manner.

The experiment which was made with

two burning wax-candles, placed in two glass jars, the one of ground glass, and the other of transparent glass, certainly proved that very little light is lost in passing through glass, or at least not much more than is lost in passing through the same kind of glass when it is transparent: but there are other experiments, by which it may be made quite evident, that screens of ground glass, and of other substances, may, under certain circumstances, be so arranged, as even to augment the intensity of the illumination of surrounding objects.

If, on a dark night, a burning candle, fixed in the centre of a cylindrical screen of ground glass, six inches in diameter, and six inches in height, be placed on a small stand, in the open air, it will illuminate surrounding objects as much as the same candle would be able to illuminate them, if the screen were made of transparent glass.

This is evident from the result of the experiment just mentioned.

If we examine the situation of this lighted candle, burning in the centre of the screen of ground glass, we shall find that a considerable portion of its light escapes through the open ends of this screen, and is entirely lost, half of it passing upwards into the clouds, and the other half passing downwards into the earth, so that no part of it is usefully employed in illuminating the surrounding objects.

If now the screen, which is only six inches in length, be removed, and another screen of ground glass, of the same diameter, and 13 inches in length, be put in its place, the whole of the surface of this taller cylinder will become luminous, and the intensity of the illumination of the surrounding objects will of course be increased. A considerable portion of the light which escaped through the open ends of the short cylinder, will be arrested by the additional length of the tall cylinder, and will be usefully employed in rendering its surface luminous.

Hence we learn, that the tall paper lanterns of the Chinese, and those which are frequently to be met with in the streets of London, in the wheel-barrows of orange-women, may possibly be useful, for other purposes than merely for preventing the flame from being disturbed by the wind.

I am persuaded, that they often increase the brightness of the illumination of surrounding objects; and that they would also do so, is most certain, if they were properly constructed and arranged, for obtaining that end. They always render a service equally important, or even more so, for they defend the eye from the direct rays of the flame, and by preventing its being deranged by them, greatly facilitates distinct vision.

In order to be able to form a just idea respecting the manner in which light is dispersed in passing through glass, and other like substances, it may be useful to examine the matter with some attention; and, as the laws which govern the rays of light in their passage through diaphanous bodies, are perfectly known, there is no difficulty whatever in explaining the phenomena, in a manner which will be perfectly satisfactory, even to those, I trust, who have not made the science of optics a part of their studies.

Light always passes from luminous bodies in strait lines; and continues to move on in the same direction, without deviation, except when it is reflected, or when it is refracted, or drawn out of its strait course, in passing out of one transparent substance into another.

When a ray of light, in passing out of the air, into glass, strikes the glass in a direction which happens to be *exactly perpendicular* to that part of the surface of the glass where it arrives, it enters the glass without being at all drawn aside, or deranged, in respect to the direction of its course; and it continues to move on in the glass, in the same strait line; and farther, if the ray, in passing out of the glass, happens to arrive at a part of the surface of the glass which is perpendicular to the direction of its course, it will pass directly through it also, and continue its course in the air, in the same direction in which it moved before it arrived at the glass.

But when a ray of light in entering glass (or any other transparent substance), meets with a surface which is not perpendicular to the direction in which it moves, the ray will be refracted, or its direction will be changed. It will appear to be drawn towards the glass before its arrives at its surface; and its motion in the glass, after it has penetrated through its surface, although it will still be in a strait line, will not be in the same direction in which the ray moved before it approached the glass; and the same change of direction will again take place, in passing out of the glass into the air, if the surface of the glass, where it makes its exit, should happen not to be perpendicular to the direction in which the ray moves in the glass, during its passage through it.

Hence we learn, that the direction of a ray of light which has passed through a glass, or any other transparent substance, will depend, not only on its original direction, but also on the refractions it has experienced in entering it, and in passing out of it: and as these refractions depend on the angles of inclination which the surface of the glass present to the ray, when the surface of the glass is so broken up by grinding, as to present an infinite number of small broken surfaces, inclined in all directions, the light which passes through it must necessarily be dispersed.

Every visible point of the surface of the glass, from which the light escapes, will appear to send off rays in all directions; and this is what gives to the glass the appearance of being luminous; and it may indeed be said to be *luminous* without any impropriety of language.

In the Memoir which I presented to the French National Institute, on the 24th of March, 1806, on the subject of lamps, I made an observation relative to the usefulness of ground glass for windows, which I shall take the liberty to repeat here.

It frequently happens, especially in large towns, that rooms are so situated as to receive no light but what comes through windows which open into narrow streets, or very small courts, and are so commanded by high buildings, as to receive very little light from above. In all such cases, rooms would be much more lighted, and much better lighted, by windows of ground glass, than by windows glazed with the finest transparent glass.

This I have found to be the case by experience, and it may easily be explained.

The rays of day-light, which descend from the Heavens, come down in a direction so nearly perpendicular to the horizon, that they impinge against the polished surface of the glass so obliquely, that most of the rays are reflected in consequence of the smallness of the angle of incidence; and as those which enter the glass, and pass through it, come into the room in such a direction that they fall on the floor, where they are mostly absorbed, they are of little use in lighting the room; but when the window is glazed with ground glass, the surface of the glass, which is rough, being on the outside, the asperities which glass presents to the descending rays greatly facilitate their entry into the glass, and as in passing through it, they are dispersed in all directions, the room will be much more equally and more intensely illuminated, than when the windows are glazed with polished glass.

The room in which the different classes of the National Institute hold their ordinary weekly meetings, is surrounded by very high buildings on every side; and its walls being covered with books quite up to the ceiling, it was exceeding dark and gloomy. All the windows have lately been furnished with double sashes, and the new outside sashes, which are nearly even with the outside of the wall, have been glazed with ground glass, the rough side of the glass being on the outside. Since this has been done, the room has become incomparably more light and cheerful, notwithstanding that the light which comes into it from without, must now pass through two panes of glass instead of one.

There are many parlours and shops on ground-floors, in narrow streets, that are so dark at mid-day, as to be scarcely habitable, which would be well lighted by the adoption of this simple contrivance; and rooms are so much more warm and comfortable with double windows, and the noise of the street is so effectually excluded by them, that these advantages alone would be sufficient to recommend them: but we see, that they may be made to furnish *light*, as well as *warmth* and *quiet*.

There are many other situations in which ground glass might be used with great advantage instead of transparent glass: but I must not enlarge on that subject in this place; perhaps I may find some other occasion of treating it more fully: in the mean time, what has been said may be useful as a hint to architects, and to those persons who are their own architects.

(To be continued.)

MECHANICAL POWER TO RAISE TREES.

A new application of mechanical power was made a few days ago in St. James's Park. The pressing machine of that truly ingenious artist, Mr. Bramah, was brought to act on a lever in such manner, that two of the largest trees in the Bird-Cage walk were torn out of the ground, with their roots to a considerable depth, in about ten minutes. The same trees could not have been felled, and their roots dug up to an equal depth, by two men, in less than four days, and the waste of timber would have been equal to the value of the labour.

SAWING IRON; AND PAINTED IRON CHIMNEY-PIECES, TO REPRESENT MARBLE.

Messrs. Millington and Co. at the Foundry at Hammersmith, lately tried the experiment of sawing cast-iron at a red heat, with a common saw. A bar of an inch and a half diameter was sawed through in the time of a similar piece of oak, and without prejudice to the saw. Simple as is the process, it is of the utmost consequence to the general introduction of cast-iron into buildings, since it now appears that it may be cut like timber to any required lengths and dimensions.

The same ingenious manufacturers have lately invented a mode of painting iron in imitation of the most costly marbles, for chimney-pieces, and other architectural ornaments. The similarity is so close as to challenge the most accurate inspection. The beauty of the finest marbles is thus happily combined with the strength and durability of cast iron.

Experiment on the existence of Miasmata.

Messrs. Thenard and Depuytren, within these two or three years, made an experiment which has thrown considerable light to the existence of *miasmata.* They agitated distilled water with hydrocarbonated gas extricated from mineral substances. This water exposed to the air and allowed to stand, was not disturbed, and gradually got rid of its hydrogen gas without being corrupted. The same experiment made with hydro-carbonated gas coming from animal putrefaction presented another result. The water became turbid, it contained flakes of a substance truly animal, which was precipitated on being allowed to rest, and the liquid was putrefied. Thus, although the gas was the same to the eyes of the experimenter, the latter contained manifestly miasmata, which gave rise to the flakes observed, and to the putrefaction of the water. M. Moscati, an eminent Italian physician, has made similar and equally interesting experiments. Having observed that the cultivation of rice, in the humid rice grounds of Tuscany, was annually attended with epidemic diseases and adynamic fevers, he conceived the idea of ascertaining the nature of the vapours which rose from the ground where rice was cultivated: with this view he suspended, at some distance from the ground, hollow spheres filled with ice. The vapours were condensed on the spheres in the form of hoar frost. He collected this substance in flasks, in which it melted, and, *at first, presented a clear liquid.* Speedily it was filled with small flakes, which, when collected and analysed, presented all the characters of an animal matter. The liquid in a short time putrified. M. Moscati made the same experiment in an hospital, by suspending the glass spheres over several sick persons: it was attended with the same phenomena and the same results. These experiments ought to be repeated and followed up; they might be varied, multiplied, and compared, with a view to elucidate the theory of contagion, which takes place without immediate contact. In this way we might also examine the alteration which miasmata undergo, when the nitric or muriatic fumigations are resorted to.

Thomas Hardacre's Patent (Glocester Place, Mary-le-bone), for a Composition to prevent the Effects of Friction.

The recipe given in this specification is as follows; "One hundred weight of plumbago, to four hundred weight of pork-lard, or beef suet, tallow, oil, goose-grease, or any other kinds of grease, but pork lard is the best, which must be well mixed together, and so incorporated as to appear one substance." This composition is to be applied in such a manner, that a sufficient quantity of the composition, to cover the surface slightly over where the bearing acts, will in general be sufficient; but where the bearing is very heavy, or the friction is great, it must not be sparingly used, particularly on steam and other engines; and the quantity to be applied to a piston rod, must be as much as will saturate whatever it is packed with; and in mills, the stone spindles must be boxed up with the composition in the same way.